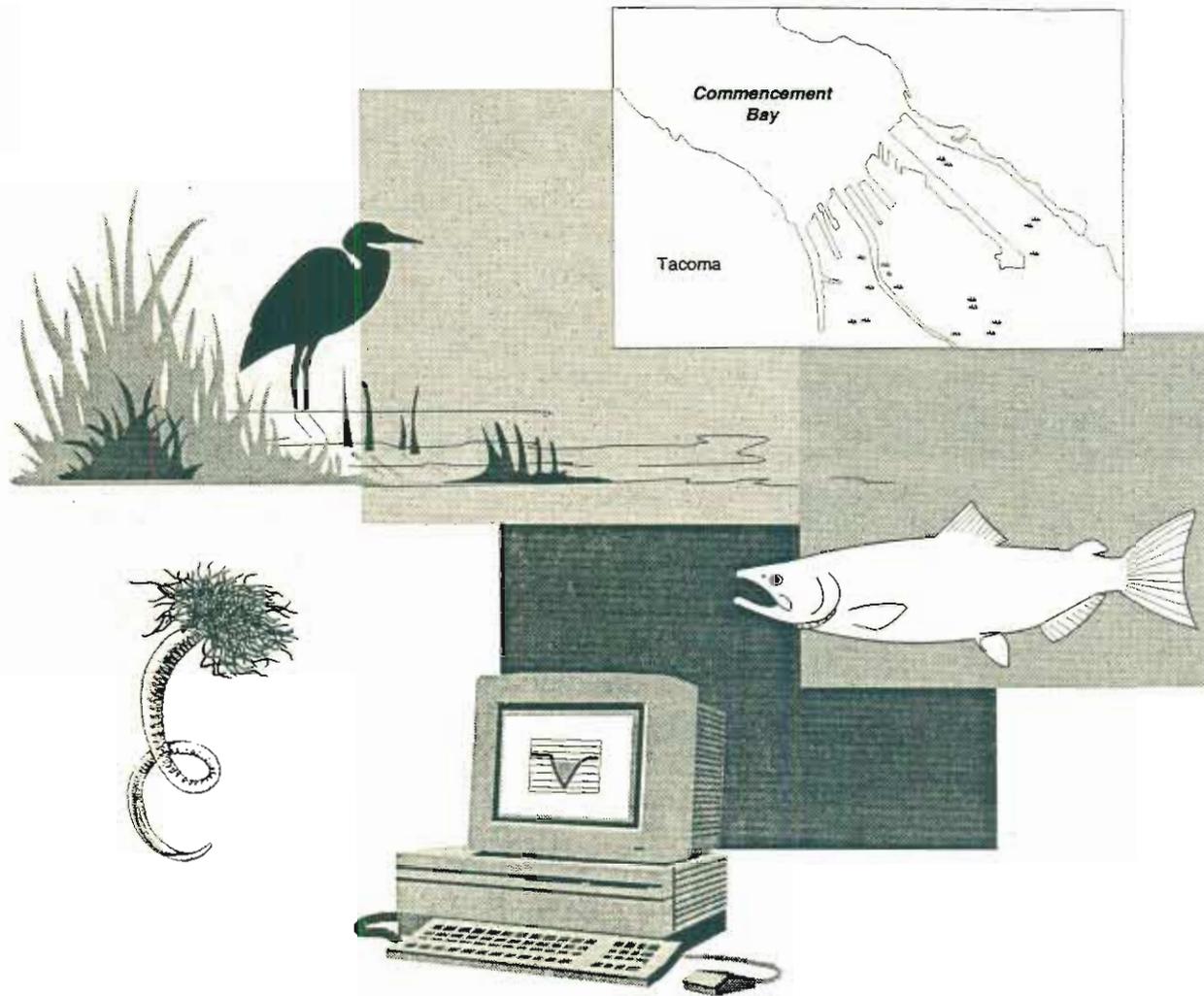


COMMENCEMENT BAY

Phase I Damage Assessment



PREPARED BY:

PREPARED FOR:



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**Commencement Bay Natural
Resource Trustees**

The National Oceanic and Atmospheric Administration of the U.S. Department of Commerce; the U.S. Department of the Interior, including the U.S. Fish and Wildlife Service; the Washington Department of Ecology, Washington Department of Fish and Wildlife, and Washington Department of Natural Resources; the Puyallup Tribe of Indians; and the Muckleshoot Indian Tribe

COMMENCEMENT BAY PHASE I DAMAGE ASSESSMENT

Prepared for: Commencement Bay Natural Resource Trustees
c/o National Oceanic and Atmospheric Administration
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EVS Project No: 2/618-01

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PREFACE

Under the Comprehensive Environmental Response, Compensation and Liability Act of 1980, 42 U.S.C. § 9601, *et seq.* (CERCLA - the federal Superfund law), several federal and state agencies and Indian tribes have been designated as trustees for the natural resources of the Commencement Bay environment (the Trustees).¹ The Trustees are responsible for determining the extent to which releases of hazardous substances and discharges of oil into the environment have injured or destroyed publicly owned or managed natural resources; calculating the economic consequences (damages) arising from the injuries and losses; identifying the potentially responsible parties who may be liable for the damages; and collecting the damages from liable parties. By law, the recovered damages are to be used to restore, rehabilitate, replace, or acquire the equivalent of the injured or lost natural resources or the services they provided. The process of identifying and quantifying the injuries and determining and collecting the monetary damages, along with the planning of efforts to restore the resource injuries, is known as a natural resource damage assessment.

The Trustees, in cooperation with a number of potentially responsible parties, are developing a natural resource damage assessment plan for Commencement Bay.² The process of planning for and implementing the bay-wide damage assessment is proceeding through a series of phases. Phase 1, which culminated in this report, involved the review of existing information to guide the development of further damage assessment studies. Based upon the information developed in this report, the Trustees are preparing plans for a series of studies that will document the nature and severity of injuries to specific natural resources resulting from identified contaminants. Those

¹ The Commencement Bay Natural Resource Trustees consist of the National Oceanic and Atmospheric Administration (NOAA) of the United States Department of Commerce (as lead administrative Trustee); the United States Department of the Interior, including the U.S. Fish and Wildlife Service and the Bureau of Indian Affairs; the Washington Department of Ecology (as lead state trustee); the Washington Department of Fish and Wildlife and the Washington Department of Natural Resources; the Puyallup Tribe of Indians; and the Muckleshoot Indian Tribe.

² The potentially responsible parties cooperating with the Trustees in Phase 1 of the damage assessment are: ASARCO Incorporated, Champion International Corporation, the City of Tacoma, Elf Atochem North America Incorporated, Kaiser Aluminum and Chemical Corporation, Mobil Oil Corporation, Occidental Chemical Corporation, the Port of Tacoma, and Weyerhaeuser Company.

injury studies, and potentially others to follow, will form the majority of Phase 2 of the assessment process. Phase 3 will mainly involve the process of assigning a dollar value to the resource injuries and determining the costs of restoration. The study plans for the different components of Phases 2 and 3 will be produced and published as separate documents.

Simultaneously with the damage assessment process, the Trustees are developing plans for restoring the injured and lost natural resources. The restoration planning is taking place through the preparation of a restoration management plan and programmatic environmental impact statement. Preparing the restoration plan at this stage will permit the Trustees to expedite restoration activities using funds from early settlements with some responsible parties. The restoration plan will also be published and distributed separately.

To avoid duplication and minimize costs, the Trustees intend to coordinate damage assessment studies with U.S. Environmental Protection Agency remedial data collection where possible and to the extent practical. To encourage settlement of natural resource damage claims short of litigation, the Trustees will attempt to develop arrangements with responsible parties to conduct damage assessment studies as joint and cooperative efforts. The Trustees' goal is to complete the damage assessment by or before the end of the year 2000 for those areas or claims not resolved by settlement.

Please Note: The sections of the Phase 1 report regarding contaminant source control and cleanup actions are necessarily limited to information available at the time those sections were prepared. Further data have subsequently been developed through the remedial planning and design processes underway in several parts of Commencement Bay. The Trustees will review and consider all data that become available from whatever source as the damage assessment process continues. Readers should contact remedial authorities for the latest information on the status of cleanup efforts.

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LIST OF ACRONYMS

AET	apparent effects threshold
AVS	acid volatile sulfide
AWQC	ambient water quality criteria
CB/NT	Commencement Bay Nearshore/Tideflats
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980 (Superfund)
DOI	U.S. Department of Interior
Ecology	Washington Department of Ecology
EIS	environmental impact statement
EqP	equilibrium partitioning
HPAH	high molecular weight polycyclic aromatic hydrocarbon
LPAH	low molecular weight polycyclic aromatic hydrocarbon
MCUL	minimum cleanup level
NRDA	natural resource damage assessment
PCA	Punch Card Area
PCBs	polychlorinated biphenyls
PCDD	polychlorinated dibenzo- <i>p</i> -dioxin
PCDF	polychlorinated dibenzofuran
PRP	potentially responsible party
RCRA	Resource Conservation and Recovery Act
RI/FS	remedial investigation and feasibility study
SMS	Sediment Management Standards
SQS	Sediment Quality Standards
SVOCs	semivolatile organic compounds
TCDD	tetrachlorodibenzo- <i>p</i> -dioxin
TCDF	tetrachlorodibenzofuran
TOC	total organic carbon
U.S. EPA	U.S. Environmental Protection Agency
VOCs	volatile organic compounds
WDF	Washington State Department of Fisheries
WDFW	Washington State Department of Fish and Wildlife

EXECUTIVE SUMMARY

Trustees for the natural resources of Commencement Bay, in cooperation with a number of the potentially responsible parties, are undertaking the development of a damage assessment plan. The initial phase of the planning process is designed to identify and assess existing information concerning injuries to Commencement Bay resources, provide preliminary guidance for the restoration planning process, and provide initial information for determining monetary damages.

This report presents a preliminary review of available data and application of the damage assessment process. The report presents information on the following topics related to the assessment of natural resource damages in Commencement Bay:

- Identification of substances of concern in Commencement Bay, as well as their sources, distribution, and factors that affect transport and movement
- Identification of the abiotic and biotic resources of concern in Commencement Bay based on their economic, cultural, or ecological importance
- Discussion of the potential abiotic and biological pathways for the transport of substances of concern, with special emphasis on trophic interactions between contaminated media and key biological resources
- Identification of injuries that have occurred, or have likely occurred, to Commencement Bay resources as the result of the release of the substances of concern
- Discussion of methods for quantifying injuries to resources and the application of those methods to identified resources injured in Commencement Bay
- Review of options that may be available to restore injured natural resources

A review of existing data on the presence of hazardous substances in Commencement Bay indicates that metals/metalloids and organic compounds are present in detectable concentrations primarily in soft-bottom sediments and in tissues of biological resources. Hazardous substances were found in sediment samples collected from the industrial waterways as well as in sediments collected from the deeper portions of the central bay. Substances of concern were selected from the hazardous substances detected in the bay,

based, in part, on their prevalence and degree of contamination compared to concentrations associated with adverse biological effects in other studies. A partial list of substances of concern for Commencement Bay includes copper, lead, mercury, zinc, polycyclic aromatic hydrocarbons, polychlorinated biphenyls, and other chlorinated hydrocarbons. Substances of concern were found to be widely distributed throughout the waterways, offshore of the closed ASARCO smelter, and in the deep-water sediments of the central bay.

Two abiotic resources, surface water and sediment, and a variety of biological resources were identified as important Commencement Bay natural resources. Key biological resources include benthic and epibenthic invertebrates, resident demersal fish species, anadromous fish, and avian species. Threatened and endangered species that may use Commencement Bay include the bald eagle, the peregrine falcon, and the marbled murrelet. In addition, the National Marine Fisheries Service is currently reviewing a petition to list the White River spring run chinook salmon under the Endangered Species Act.

The biological resources in Commencement Bay can be exposed to the substances of concern through direct contact with contaminated media or through trophic interactions. In addition to direct exposure to hazardous substances through food, higher-trophic-level consumers can also be injured if the quality or quantity of their food resources are affected by exposure to contaminated media. To identify potential exposure pathways for the substances of concern and to aid in identifying injured resources, a conceptual food web model was constructed for Commencement Bay. The model illustrates potential exposure pathways to the substances of concern through feeding, as well as the importance of some biological groups as prey for key resource species. In Commencement Bay, the benthic community is the principal food resource for the majority of the higher-trophic-level species. Because benthic species are directly exposed to the reservoir of the substances of concern found in the sediments, they provide the key link in the pathway to higher-level consumers.

Categories of natural resource injuries that have been demonstrated, or are potentially present, in Commencement Bay resources and the resources to which they likely apply include:

- Exceedence of state quality standards — sediments
- Death — benthic invertebrates, salmonids, flatfish, and birds
- Disease — flatfish and salmonids
- Behavioral abnormalities — flatfish and birds

- Cancer — flatfish
- Reproductive dysfunction — flatfish
- Genetic mutations — flatfish, salmonids, and birds
- Physiological dysfunction — benthic invertebrates, salmonids, flatfish, and birds
- Physical deformities — flatfish and birds
- Advisories against consuming fish and shellfish

The categories of resource injuries are based on a review of existing data from Commencement Bay and information concerning the likely impacts of identified substances of concern. Of the eight injury categories, elevated concentrations of the substances of concern leading to the posting of fishing advisories and death are the best documented. Immunosuppression and other forms of physiological dysfunction, although not well documented to date in Commencement Bay, may also prove to be important injury categories.

The Trustees are conducting restoration planning to determine what type of restoration activities are appropriate to benefit Commencement Bay natural resources. As part of the planning process, a Restoration Plan and programmatic Environmental Impact Statement (RP/EIS) are being prepared for the Commencement Bay environment.

1.0 INTRODUCTION

Commencement Bay is a deep-water embayment that occupies approximately 5,700 acres in south Puget Sound (Figure 1-1). In 1982, a portion of Commencement Bay was designated as a Superfund site. The Commencement Bay Nearshore/Tideflats (CB/NT) site was added to the National Priorities List after fish, shellfish, and sediments within the waterways were found to have elevated concentrations of hazardous substances. In 1983, the U.S. Environmental Protection Agency (U.S. EPA) and the Washington Department of Ecology (Ecology) initiated a remedial investigation and feasibility study (RI/FS). A Record of Decision for the site was entered in 1989 (U.S. EPA, 1989).

The Trustees for the natural resources of Commencement Bay, in cooperation with a number of the potentially responsible parties (PRPs), are undertaking the development of a damage assessment plan. The initial phase of the planning process is designed to identify and assess existing information concerning injuries to Commencement Bay resources, provide preliminary guidance for the restoration planning process, and provide initial information for determining monetary damages. This planning effort will use existing natural science and economic data to identify injuries to Commencement Bay resources and to prepare the injury determination portion of the damage assessment plan. This document presents a preliminary review of available data and application of the damage assessment process. It represents a synthesis of information acquired up to 1993 through repeated inquiries to local municipal, state, and federal agencies; industries; and university researchers. It is recognized that more recent data for some aspects covered in this report have become available, and it is possible that additional past studies were performed but were not made available to the authors.

1.1 INJURY AND RESTORATION STUDY AREAS

The Injury Study Area coincides with the boundaries of the CB/NT Superfund Site. Boundaries of the Injury Study Area are defined as follows:

The upland boundaries of the site are defined according to the contours of localized drainage basins that flow into the marine waters. The marine boundary of the site is

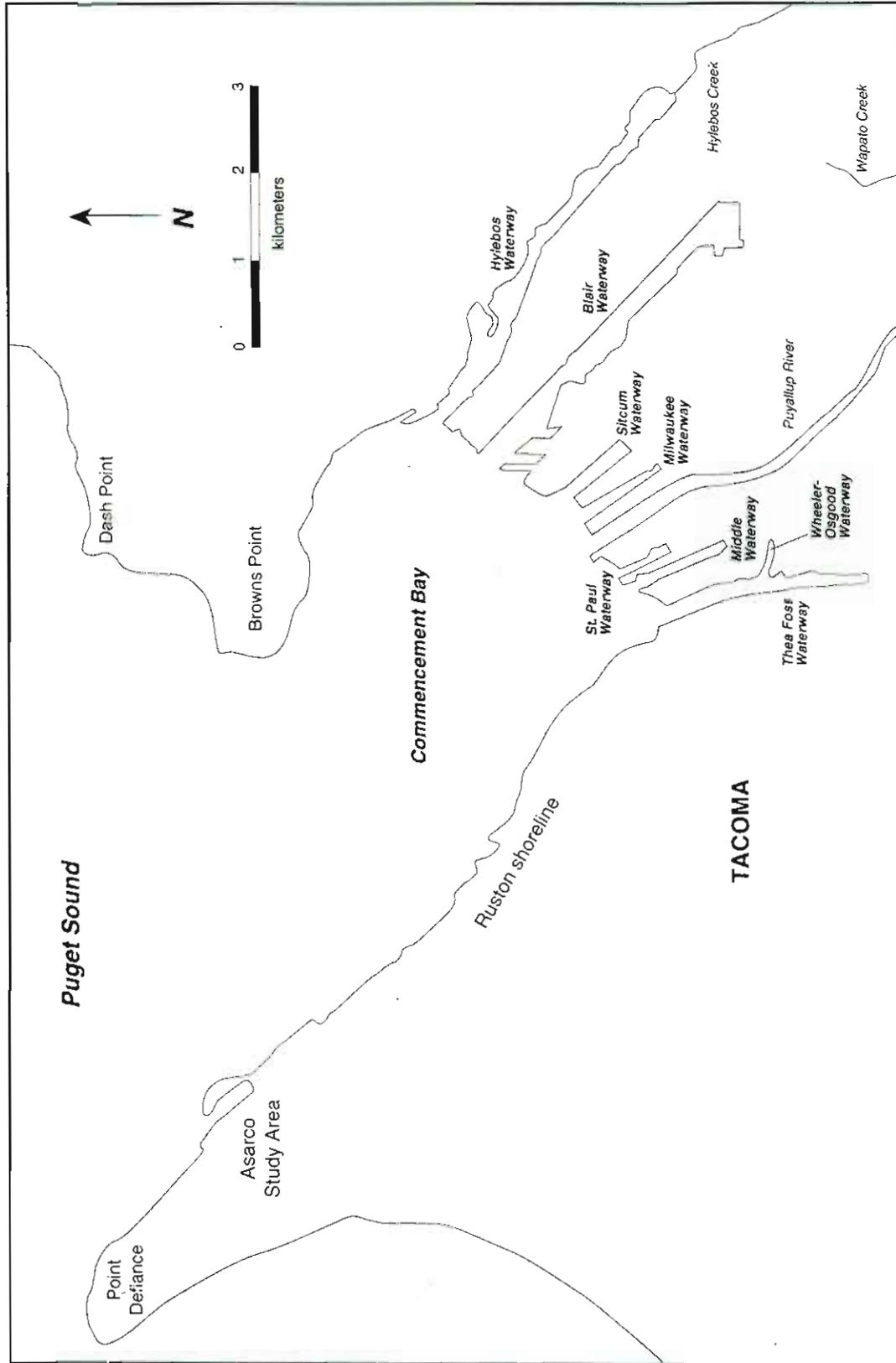


Figure 1-1. Commencement Bay area.

limited to the shoreline, intertidal areas, bottom sediments, and water depths less than 60 ft below mean lower low water. The nearshore portion of the site is defined as the area along the Ruston Shoreline from the mouth of the City (Thea Foss) Waterway to Point Defiance. The tideflats portion of the site includes the Hylebos, Blair, Sitcum, Milwaukee, St. Paul, Middle, Wheeler-Osgood, and Thea Foss Waterways; the Puyallup River upstream of the Interstate-5 bridge; and the adjacent land area. Because the landward boundary of the CB/NT site is defined by drainage pathways rather than political boundaries, the precise landward extent of the site may be adjusted as new information regarding surface water and groundwater flow patterns is developed.

The Restoration Study Area includes the Injury Study Area and areas beyond, including:

- The Hylebos Creek corridor upstream of Interstate-5 to its fork near Interstate-5 and Porter Way, the East Fork of Hylebos Creek to Kit Corner Road (Highway 161), and the West Fork's western tributary to 348th Street
- The mainstream Wapato Creek corridor from Melroy Street to Meridian Street
- The Puyallup River corridor from the Melroy Street bridge to Meridian Street
- The southern tip of Vashon Island from Spring Beach to Martin Street, north of Neill Point
- The southern tip of Maury Island from the Tacoma Yacht Club to the public access area just north of Shore Acres
- The shoreline north and east of Browns Point to Lakota Beach County Park
- The shoreline south of Point Defiance to the Nelson Bennet railroad tunnel

1.2 REPORT ORGANIZATION

This report contains eight sections and nine appendices. Section 2.0 identifies the substances of concern in the Injury Study Area and discusses their sources, distribution, and factors affecting their movement. Section 3.0 identifies the abiotic and biological resources of concern based on their economic, cultural, or ecological importance that are currently or were historically found in the Injury Study Area. A discussion of the potential abiotic and biological pathways for the transport of contaminants, with special emphasis on trophic

interactions between contaminated media and the key biological resources, is presented in Section 4.0. Section 5.0 describes the injuries that have been identified in the Injury Study Area, as well as injuries that have been associated with the substances of concern, but not yet observed in Commencement Bay. Quantification and scaling of resources are described in Section 6.0. A review of the restoration options that are available based on the preliminary restoration planning approach(es) adopted by the Commencement Bay Coordinating Committee is presented in Section 7.0. The literature cited throughout this report can be found in Section 8.0.

1.3 REFERENCE NOTE

The intent of this report is to describe and summarize information from a variety of sources regarding Commencement Bay. Cited documents may contain statements regarding remediation of areas of contamination, control of sources of contamination, or recovery of contaminated areas that represent judgments or conclusions by the authors or issuing parties. Citations to such documents, and inclusion of any such statements in this report, are intended solely for purposes of reference and are not necessarily intended as endorsement or adoption of or concurrence in such judgments or conclusions.

2.0 SUBSTANCES OF CONCERN IN THE INJURY STUDY AREA

2.1 IDENTIFICATION OF SUBSTANCES OF CONCERN

The U.S. Department of Interior (DOI) regulations (43 CFR Part 11) identify hazardous substances as a concern if their release has or will likely cause injury to natural resources. This section provides an overview of hazardous substances detected in Commencement Bay and identifies those hazardous substances of concern (SOCs) that may result in injury to natural resources.

2.1.1 Surface Water

Very few recent surface water quality studies have been conducted that measured the concentration of hazardous substances in Commencement Bay. Only four water quality studies were available for review, including Riley et al. (1980, 1981), Dames & Moore (1981a), and City of Tacoma (1990). Other surface water studies, such as the Ecology sediment trap studies and water quality studies conducted as part of the remedial investigation (Tetra Tech, 1985), analyzed suspended sediment and particulate matter as opposed to dissolved concentrations within the water column.

Riley et al. (1980, 1981) collected water samples from nine stations within Blair and Hylebos Waterways in 1980 and 1981 and analyzed samples for organic compounds. In 1980, Dames & Moore (1981a) conducted a comprehensive bay-wide investigation and sampled 33 stations: 13 stations in 7 of the waterways, 4 stations in drainages discharging to the bay, and 16 stations off the Ruston Shoreline or within the bay proper. Samples were analyzed for total PCBs and trace elements. The City of Tacoma (1990) collected water samples in 1986 and 1987 from five outfalls discharging to Thea Foss, Wheeler-Osgood, and Sitcum Waterways. Outfall samples were analyzed for the U.S. EPA priority pollutant metals/metalloids, acid/base/neutral compounds, and pesticides.

The Dames & Moore (1981a) water column study reported elevated concentrations of several toxic metals/metalloids within Commencement Bay. Concentrations of copper exceeded the marine acute ambient water quality criterion (AWQC) along the Ruston-Pt. Defiance Shoreline and in all of the waterways except for Middle Waterway. Arsenic exceeded the

AWQC in the Hylebos Waterway. The water column studies within the bay did not find organic compounds at concentrations exceeding AWQC with one exception — the concentration of total PCBs (0.64 µg/L Aroclor 1016) at one station in Hylebos Waterway exceeded the AWQC by an order of magnitude.

The City of Tacoma (1990) outfall data indicated that waters discharging to the bay were contaminated with several substances, including seven toxic metals/metalloids and four pesticides. Lead, mercury, nickel, and zinc exceeded marine AWQC in all five outfalls discharging to Thea Foss, Wheeler-Osgood, and Sitcum Waterways. The concentrations of all four metals exceeded their respective criteria by 1 order of magnitude. The concentrations of arsenic and cadmium also exceeded the criteria, but only in one or two samples. The pesticides dieldrin, endosulfan, endrin, and DDT were detected at concentrations of less than 1 µg/L, but exceeded their respective AWQC. The exceedances by the pesticides were sporadic compared with those for metals/metalloids. In addition, the concentration of pentachlorophenol exceeded its AWQC in one sample. Several other organic compounds were detected in outfall samples, primarily polycyclic aromatic hydrocarbons (PAHs) and other semivolatile organic compounds (SVOCs), but concentrations never exceeded their respective marine chronic AWQC.

Other data sets, such as outfall, point source runoff, or estuarine water column data, may be available through Ecology. Several Ecology memoranda have been identified, but were not available for review at the time of the preparation of this document. These memoranda include:

- Ecology 1981–1983. Receiving water surveys — Separate Ecology memorandums assessing water quality in the vicinity of U.S. Oil and Refining Co., St. Regis Paper Co., Pennwalt Corporation facility, Sound Refining facility, Reichhold Chemicals, and ASARCO.
- Ecology 1981–1985. Hooker Chemical Co. receiving water study — Series of memorandums to and from Ecology.

These memoranda present data collected from areas in the immediate vicinity of specific industries.

2.1.2 Sediment

The concentrations of hazardous substances measured in the sediment of Commencement Bay were compiled from existing databases and published reports and reviewed. Only data for surficial sediment samples (i.e., 0 to 2 cm) or the surface section of cores with a maximum composited sample depth of 0 to 1.2 m were used for this evaluation. A list of the studies from which data were compiled is presented in Table 2-1. Several other studies and summary databases (Table 2-2) were identified, but data from those sources were not incorporated directly into this report. The additional data sources listed in Table 2-2 should be reviewed to confirm the final list of SOCs.

Numerous inorganic and organic hazardous substances have been detected in the sediments of Commencement Bay in various studies conducted between 1979 and 1992; these are summarized in Table 2-3. The detected substances include metal/metalloids, volatile organic compounds (VOCs), PAHs, phthalate esters, phenols, pesticides, and polychlorinated biphenyls (PCBs).

2.1.3 Tissues

The degree to which hazardous substances are present in the tissues of Commencement Bay fish, shellfish, and birds has been addressed in numerous studies. These studies, study parameters, problem areas sampled, and substances measured are summarized in Table 2-4. This section presents a discussion of the scope of the bioaccumulation studies conducted in Commencement Bay and identifies the contaminants measured.

2.1.3.1 Aquatic Species

The studies conducted with aquatic resources in Commencement Bay find that the substances observed most frequently, with the widest spatial distribution, and in the most different species were several chlorinated organic compounds including PCBs, chlorinated butadienes, and hexachlorobenzene. Naphthalene, several phthalate esters, and the toxic metals/metalloids arsenic, chromium, copper, mercury, nickel, and zinc have also been observed in tissues of aquatic species at concentrations significantly above reference concentrations.

**Table 2-1. Sources of Sediment Data
for Commencement Bay Used to Identify Substances of Concern**

SURVEY	SAMPLING DATES	LOCATION	REFERENCE
1980 National Oceanic and Atmospheric Administration OMPA Survey of Puget Sound	1979–1980	Commencement Bay Open Water and Waterways	Malins et al., 1982
Commencement Bay Deep Water Sediment Survey	1982	Commencement Bay Open Water	U.S. EPA, 1983
Commencement Bay Nearshore/ Tideflats RI/FS	1980–1986 (includes historical data)	Hylebos Waterway Blair Waterway Sitcum Waterway Milwaukee Waterway St. Paul Waterway Middle Waterway Wheeler-Osgood Waterway Thea Foss Waterway Ruston-Pt. Defiance Shoreline	Tetra Tech, 1985; 1988
Sitcum Waterway Pre-Remedial Design Natural Resource Data Report	1991	Blair Waterway Sitcum Waterway Milwaukee Waterway	Port of Tacoma, 1991; 1992
ASARCO RI/FS; Supplementary Marine Sediment Survey; Supplemental Marine Yacht Basin Survey	1987–1992	Ruston-Pt. Defiance Shoreline	Parametrix, 1989a,c; 1992; 1993
St. Paul Remedial Action and Habitat Restoration Monitoring Report	1988–1991	St. Paul Waterway (cap monitoring site)	Parametrix, 1990b; 1991a

**Table 2-2. Sources of Sediment Data
for Commencement Bay Not Incorporated in this Report**

SURVEY	LOCATION	REFERENCE
1980 National Oceanic and Atmospheric Administration OMPA Survey of Puget Sound	Commencement Bay (Stations 15-22)	Malins et al., 1981
Puget Sound Dredged Disposal Analysis Program	Commencement Bay Waterways	Washington Department of Ecology, Sediment Management Unit, SEDQUAL database
Puget Sound Ambient Monitoring Program	Commencement Bay	Washington Department of Ecology, Sediment Management Unit, SEDQUAL database
U.S. EPA National Estuary Program	Commencement Bay	Washington Department of Ecology, Sediment Management Unit, SEDQUAL database
National Oceanic and Atmospheric Administration Status and Trends Program	Commencement Bay	Washington Department of Ecology, Sediment Management Unit, SEDQUAL database
Thea Foss and Wheeler-Osgood Round 1 Data Collection	Thea Foss and Wheeler-Osgood Waterways	Hart Crowser, 1994
Hylebos Waterway Pre-remedial Design	Hylebos Waterway	Striplin, 1994
Upper Hylebos Waterway Property Investigation	Hylebos Waterway	Landau, 1991; Landau, 1993
Occidental Chemical Resource Conservation and Recovery Act Investigation	Hylebos Waterway	Conestoga-Rovers & Associates, 1989

**Table 2-3. Summary of Hazardous
Substances Detected in Commencement Bay Sediments**

SURVEY	YEAR	STATION LOCATIONS	CONTAMINATES DETECTED	
			TOTAL METALS/METALLOIDS	ORGANIC COMPOUNDS
National Oceanic and Atmospheric Administration OMPA survey of Puget Sound	1979–1980	Commencement Bay and Waterways	arsenic cadmium chromium copper lead mercury nickel zinc	LPAHs HPAHs PCBs
Commencement Bay Deep Water Sediment Survey	1982	Central Commencement Bay	arsenic beryllium cadmium chromium copper lead mercury nickel selenium zinc	LPAHs HPAHs phthalate esters phenols VOCs pesticides PCBs
Commencement Bay Nearshore/Tideflats RI/FS	1980–1986	Commencement Bay Waterways	antimony arsenic cadmium copper lead mercury nickel silver zinc	LPAHs HPAHs phthalate esters phenols VOCs pesticides PCBs
Sitcum Waterway Pre-Remedial Design Natural Resource Data Report	1991	Blair, Sitcum, and Milwaukee Waterways	antimony arsenic cadmium copper lead mercury nickel silver zinc	LPAHs HPAHs phthalate esters phenols VOCs pesticides PCBs
ASARCO RI/FS; Supplemental Marine Sediment Survey; Supplemental Marine Yacht Basin Survey	1987–1992	Ruston-Pt. Defiance Shoreline in vicinity of slag pile; yacht basin	arsenic copper lead mercury zinc	LPAHs HPAHs phthalate esters phenols
St. Paul Remedial Action and Habitat Restoration Monitoring Report	1988–1991	St. Paul Waterway (cap monitoring site)	copper lead nickel zinc	LPAHs HPAHs phthalate esters phenols PCBs

Note: HPAH - high molecular weight polycyclic aromatic hydrocarbons
 LPAH - low molecular weight polycyclic aromatic hydrocarbons
 PCBs - polychlorinated biphenyls
 VOC - volatile organic compound

**Table 2-4. Summary of Studies that Measured
the Concentration of Hazardous Substances in Biota in Commencement Bay**

STUDY	YEAR SAMPLES COLLECTED	NO. OF TISSUE STATIONS	SPECIES	ANALYTES MEASURED	LOCATIONS SAMPLED	SUBSTANCES IDENTIFIED/LOCATION
Aquatic Species						
Galer et al., 1982	1981, 1982	4	Flathead sole, rock sole, starry flounder, buffalo sculpin, staghorn sculpin, Pacific tomcod, English sole, pollock, greenling, hake, Pacific cod, Dungeness crab	U.S. EPA TCL substances	Hylebos, Thea Foss Pt. Defiance Shoreline	Chromium, PCBs, HCB/Hylebos Waterway Chromium, nickel, PCBs/Thea Foss Waterway Arsenic, chromium, nickel, PCBs/Ruston-Pt. Defiance Shoreline
Malins et al., 1982	1979-1981	13	English sole, rock sole, chinook salmon, coho salmon, Pacific ccd, Pacific tomcod, staghorn sculpin, quillback rockfish, cancrid crabs, Macomid clams, Pandalid/Crangon shrimp	Metals/metalloids, PAHs, PCBs, chlorinated pesticides, other chlorinated organic compounds	Hylebos, Blair, Sitcum, and Thea Foss Waterways; Ruston-Pt. Defiance Shoreline	Arsenic, PAHs, PCBs, CBD, HCB, DDT/Hylebos Waterway
Malins et al., 1984	1980-1984	12	English sole, rock sole, staghorn sculpin	Metals/metalloids, PAHs, PCBs, chlorinated pesticides, other chlorinated organic compounds	Hylebos, Blair, Sitcum, and Thea Foss Waterways; Ruston-Pt. Defiance Shoreline	PCBs, CBD, HCB/Hylebos Waterway
Tetra Tech, 1985	1984	15	English sole, cancrid crab	U.S. EPA TCL substances	All waterways and Ruston-Pt. Defiance Shoreline	Mercury, DBP, PCBs/Hylebos Shoreline BEHP, PCBs/Blair Shoreline Copper, PCBs/Sitcum Waterway Copper/St. Paul Waterway Naphthalene, BEHP/Middle Shoreline PCBs/Thea Foss Shoreline Copper/Ruston-Pt. Defiance Shoreline
Landolt et al., 1985	1983, 1984	3	Pacific cod, English sole, sablefish, squid	Arsenic, cadmium, lead, PCBs	Ruston-Pt. Defiance Shoreline	Arsenic/Ruston-Pt. Defiance Shoreline
Port of Tacoma, 1992	1991	29 trawls	English sole, red rock crab, Dungeness crab	U.S. EPA TCL substances	Blair, Sitcum, and Milwauke Waterways	PCB 1254/Blair Waterway Copper, zinc, PCB 1254/Sitcum Waterway PCB 1254/Milwauke Waterway

Table 2-4. continued

STUDY	YEAR SAMPLES COLLECTED	NO. OF TISSUE STATIONS	SPECIES	ANALYTES MEASURED	LOCATIONS SAMPLED	SUBSTANCES IDENTIFIED/LOCATION
U.S. EPA, 1992a	1991	2	Starry flounder, Dungeness crab, quillback rockfish, rattfish, big skate	PCDDs, PCDFs	Commencement Bay, Hylebos Waterway	PCDDs, PCDFs/Commencement Bay, Hylebos Waterway
Varanasi et al., 1993	1989, 1991	19	Juvenile chinook salmon	PAHs, PCBs, organofin compounds	All waterways, except Sitcum	PAHs, PCBs/All waterways
BIRDS						
Riley et al., 1983	1982	1	Great blue heron, glaucous-winged gull	Metals/metalloids, PCBs, pesticides	Bay-wide	Lead, mercury, PCBs/Bay-wide
Henny et al., 1990	1985, 1986	1	Western grebe	Metals/metalloids, PCBs, pesticides	Head of waterways	Arsenic, mercury, DDE, PCBs, chlordane/Head of waterways
Henny et al., 1991	1984, 1985	1	Surf scoter	Metals/metalloids, PCBs, pesticides	Bay-wide	Aluminum, cadmium, copper, lead, mercury, magnesium, selenium, zinc, PCBs, DDE/Bay-wide

Note: BEHP - bis(2-ethylhexyl) phthalate

CBD - chlorinated butadiene

DBP - di-n-butyl phthalate

HCB - hexachlorobenzene

PAH - polycyclic aromatic hydrocarbon

PCB - polychlorinated biphenyl

PCDD - polychlorinated dibenzo-*p*-dioxin

PCDF - polychlorinated dibenzofuran

TCDD - tetrachloro dibenzo-*p*-dioxin

TCL - Target Compound List

Most of the data on the concentration of substances in tissues from Commencement Bay was collected during the early to mid-1980s; three additional studies were conducted between 1989 and 1991 (Table 2-4). The remedial investigation conducted at the site (Tetra Tech, 1985) provided the most comprehensive data set for aquatic species. English sole (*Pleuronectes vetulus*) and cancrivora crabs were collected from all of waterways, and along the Ruston-Pt. Defiance Shoreline and tissues were analyzed for all U.S. EPA priority pollutants. Concentrations of inorganic and organic hazardous substances were measured in sole and crab collected in six waterways and along the Ruston-Pt. Defiance Shoreline at concentrations greater than those observed in the same species collected from a reference area. PCBs were the most prevalent. Other organic compounds detected at significantly higher concentrations than reference were naphthalene, bis(2-ethylhexyl) phthalate, and di-n-butyl phthalate. Metals detected at concentrations above reference included copper and mercury.

Findings similar to those presented in Tetra Tech (1985) were reported in the other studies. Landolt et al., (1985) reported that PCBs were the most prevalent substances detected. In addition, arsenic was detected at elevated concentrations in fish collected at popular recreational fishing areas along the Ruston-Pt. Defiance Shoreline. Varanasi et al. (1993) reported higher concentrations of PCBs in liver tissue of juvenile salmonids collected in Commencement Bay than those collected in the Nisqually Delta, a reference estuary. Elevated concentrations of hexachlorobenzene and chlorinated butadienes were also detected in fish collected in Hylebos Waterway in three separate studies (Table 2-4). Consistent with Tetra Tech (1985), Varanasi et al. (1993) also reported elevated concentrations of PAHs in salmonids. None of the studies found markedly higher concentrations of chlorinated pesticides than those reported for reference areas. Based on a review of existing tissue residue data for English sole and crabs in Commencement Bay, the Tacoma-Pierce County Health Department identified a number of substances that were present in concentrations that could cause carcinogenic and noncarcinogenic human health effects in consumers of the contaminated resources. The maximum tissue concentrations of these substances in English sole and crabs collected in Commencement Bay are presented in Table 2-5.

As part of a national study of chemical residues in fish, U.S. EPA (1992a) collected fish and crab samples in Commencement Bay and analyzed their tissues for polychlorinated dibenzo-

**Table 2-5. Hazardous Substances Measured in
Tissues of English Sole and Crab Identified as Being
of Concern by the Tacoma-Pierce County Health Department**

CHEMICAL	MAXIMUM CONCENTRATION ^a (mg/kg)	
	SOLE	CRAB
Antimony	1.2	2.2
Arsenic	18.0	3.4
Cadmium	0.22 Z	0.62 Z
Chromium	0.47	0.36
Lead	0.62 Z	2.05 Z
Nickel	0.24	0.22
Selenium	8.5	1.0
Mercury	0.15	0.29
Zinc	11.0	50.0
Naphthalene	1.8	1.20 Z
Phenanthrene	ND	0.029
Di-methyl phthalate	0.26	ND
Bis (2-ethylhexyl) phthalate	0.98 Z	0.26 Z
Butylbenzyl phthalate	0.24	ND
Pentachlorophenol	0.48	ND
Hexachlorobenzene	0.07	ND
Hexachlorobutadiene	0.07	ND
Tetrachloroethene	0.21	ND
1,3-Dichlorobenzene	0.53	0.02 U
Total PCBs ^b	1.3	0.48

Source: WSDH (1992).

^a U - undetected at the detection limit

ND - not detected; detection limit not available

Z - corrected for blank

^b Total polychlorinated biphenyls were measured as Aroclor 1260.

p-dioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). Several congeners of PCDDs and PCDFs, including 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD), were measured in tissues of big skate (*Raja binoculata*), ratfish (*Hydrolagus colliei*), starry flounder (*Platichthys stellatus*), rockfish, and Dungeness crab.

2.1.3.2 Birds

Measures were made of the concentrations of hazardous substances in several species of waterfowl in Commencement Bay in the early to mid-1980s (Table 2-4). Because of the mobility of many birds, collections were not made in specific problem areas; most collections were considered to represent bay-wide exposure. Riley et al. (1983) provides the most comprehensive study of the tissues of birds collected in Commencement Bay. Hazardous substances measured included PCBs, mercury, and lead. PCBs were found in the tissues of great blue heron (*Ardea herodias*), while PCBs, mercury, and lead were found in tissues of glaucous-winged gulls. Henny et al. (1990, 1991) reported that the concentrations of PCBs, chlorinated pesticides, and several toxic metals/metalloids in tissues of western grebe and surf scoter collected in Commencement Bay between 1984 and 1986 were greater than the concentrations of those substances in the same species collected from reference areas.

2.1.4 Screening Guidelines for Identifying Substances of Concern

Three fundamental criteria from the DOI's natural resource damage assessment (NRDA) regulations (43 CFR Part 11) were used to identify SOCs:

- Substances present at concentrations that exceed applicable quality criteria promulgated by the federal or state government
- Substances present at concentrations that are toxic (i.e., can cause a biological injury)
- Substances present at concentrations that result in advisories to limit or ban the consumption of resources

These screening approaches are discussed in more detail below, followed by a summary of the substances measured in the media of Commencement Bay that exceed one or more of the criteria.

2.1.4.1 Exceedance of Promulgated Criteria

Surface Water

Although evaluating the exceedance of promulgated criteria is a straightforward approach to identifying SOCs, it is not applicable for all environmental media because criteria have not been developed for all media. In addition, some criteria are established for a specified use of a resource (e.g., use of surface water as a drinking water source) that would not apply if the resource were not used for that purpose.

Ecology administers the Clean Water Act in the State of Washington, including the application of water quality criteria to Commencement Bay. Under § 303(d) of the Clean Water Act, Commencement Bay is considered water-quality-limited, which is defined as an area where it is known that the water quality does not meet applicable water quality standards and/or is not expected to meet applicable water quality standards, even after the application of technology-based effluent limitations.

The waters of Commencement Bay have been classified under one of three designated use classifications (i.e., Class A, B, or C), depending on the location within the bay. Designated uses for Class A waters are:

- Fish rearing, spawning, and harvesting
- Salmonid migration
- Clam, oyster, and mussel rearing, spawning, and harvesting
- Crab and shrimp rearing, spawning, and harvesting
- Primary contact
- Secondary contact
- Navigation
- Wildlife habitat

Designated uses for Class B waters are:

- Fish rearing, spawning, and harvesting
- Salmonid migration
- Clam, oyster, and mussel rearing and spawning
- Crab and shrimp rearing, spawning, and harvesting

- Secondary contact
- Navigation
- Wildlife habitat

Designated uses for Class C waters are:

- Secondary contact
- Navigation
- Wildlife habitat

Ecology has identified the waters of outer Commencement Bay as Class A Waters. Inner waters are classified as either Class B or C waters, depending upon location. Waters south and east of a line bearing 225° true through Hylebos Waterway light, except the City Waterway (Thea Foss Waterway) south and east of South 11th Street, are classified as Class B waters, while the waters of the Thea Foss Waterway south and east of South 11th Street are classified as Class C waters.

Numerical limits have been established by the state for Classes A, B, and C and are based on the concentrations of conventional parameters and toxic substances that are considered acceptable to protect the designated user of that water classification. While the criteria for conventional parameters are different for each class designation, the same criteria apply to toxic substances for all classes. The criteria for toxic substances are promulgated in the water quality standards for surface waters (Chapter 173-201A WAC) for the State of Washington.

The promulgated criteria are based on the U.S. EPA AWQC. The criteria for cadmium, copper, lead, nickel, silver, and zinc are based on the dissolved concentrations of the metals. The criterion for arsenic is based on the total-recoverable concentration. The data for the concentrations of cadmium, copper, lead, nickel, silver, and zinc in the surface water of Commencement Bay summarized in Section 2.1 have been reported as the total-recoverable fraction of the metals. For the purposes of this screening exercise, these data represent conservative concentrations for comparison with the applicable water quality criteria.

Sediments

Ecology has promulgated Sediment Management Standards (SMS) for the State of Washington (Chapter 173-204 WAC) that are applicable to the marine waters of

Commencement Bay. The SMS include two guideline concentrations for each managed substance in sediment, each concentration having a different management application. The lower concentration, the Sediment Quality Standard (SQS), defines the highest concentration of a substance in sediment that could be present without the sediment causing adverse effects in biological resources. The higher concentration, the Minimum Cleanup Level (MCUL), establishes a minimum sediment cleanup standard based on the concentration at which limited adverse impacts to biological resources may occur. U.S. EPA is also currently developing sediment quality criteria. Because only draft standards have been published, and for only for six organic compounds, these standards were not considered applicable for this effort.

The Record of Decision for the Commencement Bay Superfund site (U.S. EPA, 1989) contains sediment quality objectives for the substances that are different than the SQS; however, the SMS are more recent and therefore a more appropriate criteria basis for the comparisons to determine exceedences that would define injury under NRDA regulations.

Tissue

Limited quality criteria have been developed for the concentrations of hazardous substances in biota. The Tacoma-Pierce County Health Department has, however, posted advisories restricting the consumption of fish and shellfish because of the high concentrations of some trace elements and organic compounds in fish and crab from Commencement Bay. The substances that initiated these restrictions are the toxic metals/metalloids antimony, arsenic, beryllium, cadmium, chromium, lead, mercury, nickel, selenium, and zinc, and the organic compounds di-methyl phthalate, bis(2-ethylhexyl) phthalate, butylbenzyl phthalate, hexachlorobenzene, hexachlorobutadiene, naphthalene, pentachlorophenol, phenanthrene, tetrachloroethane, 1,3-dichlorobenzene, 4,4'-DDD, 4,4'-DDE, and PCBs (WSDH, 1992). Substances present at concentrations resulting in restrictions in the use of a resource are considered to have injured that resource. Therefore, the substances initiating the advisories would be considered SOCs.

2.1.4.2 Toxicity-based Criteria

Both the AWQC and SQS concentrations are based, in part, on the results of toxicity testing and observed biological effects in the field. AWQC for acute effects are derived from

laboratory toxicity tests that measure the response of a variety of aquatic species following short-term exposure to toxic substances. Chronic AWQC are derived either from laboratory tests using longer-term exposures or from laboratory or *in situ* observations of the bioaccumulation of the toxic substances. SQS concentrations for sediments are based on the Apparent Effects Threshold (AET) (Chapter 173-204 WAC). The applicable AET approach uses chemical concentrations in sediments and at least one indicator of bioavailability/bioeffects (i.e., sediment bioassays or benthic infaunal community structure) to determine the concentration of a particular contaminant above which statistically significant biological effects are always expected to occur (Tetra Tech, 1985). Both the AWQC (for water) and the SQS (for sediments) thus constitute threshold concentrations above which toxicity can occur. Concentrations of substances that exceed these criteria concentrations are therefore identified as SOCs because they are expected to be toxic (i.e., injure natural resources).

Data associating injury to biota to the concentrations of hazardous substances in tissues have not been compiled as they have for water and sediments. The evaluation of whether the concentrations of the substances that have been measured in tissues of species from Commencement Bay constitute an injury should be deferred until an analysis of the observed injuries is conducted, at which time the relevance of tissue concentrations of SOCs can be better assessed. However, for this report, those substances measured in tissues with higher concentrations in Commencement Bay than in reference areas were identified as SOCs.

2.1.4.3 Summary of the Guidelines for Selecting Substances of Concern

For this assessment, the guidelines for identifying SOCs in Commencement Bay surface water, sediment, and biota are:

- **Surface Water** — Marine chronic AWQC. Substances that have been measured in the surface waters of Commencement Bay at concentrations that exceed the relevant AWQC are presented in Table 2-6 together with the general location where the measurements were made.
- **Sediment** — SQS concentrations. Table 2-7 presents a list of substances that have been measured in the sediments of Commencement Bay at concentrations that exceed the relevant SQS.

Table 2-6. Comparison of Available Maximum Concentrations of Hazardous Substances in Outfall and Surface Water Samples Collected in Commencement Bay and U.S. EPA AWQC for the Protection of Marine Life (chronic criteria)

HAZARDOUS SUBSTANCE	OUTFALL SAMPLES					WATER COLUMN SAMPLES										AWQC
	Sitcum Waterway	Wheeler-Osgood	Thea Foss	Hyabos Waterway	Blair Waterway	Sitcum Waterway	Milwaukee Waterway	St. Paul Waterway ^a	Middle Waterway	Thea Foss	Ruston Shoreline	Commencement Bay				
Arsenic	1,760	11	7	50	ND	ND	ND	ND	ND	ND ^a	ND	ND	36			
Cadmium	4.1	3.2	63	ND	ND	ND	ND	ND	ND	ND	ND	3	9.3			
Copper	473	440	780	7	4	3	8	8	ND	9	8	5	2.9			
Lead	335	130	210	ND	ND	ND	ND	ND	ND	ND	ND	ND	5.6			
Mercury	.04	.04	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.0025			
Nickel	120	190	300	ND	ND	ND	ND	ND	ND	ND	ND	ND	8.3			
Zinc	942	1,520	3,490	16	10	ND	31	8	9	25	21	13	86			
Dieldrin	0.02	ND	0.05	—	—	—	—	—	—	—	—	—	0.0019			
Endosulfan	0.012	ND	0.06	—	—	—	—	—	—	—	—	—	0.0087			
Endrin	ND	ND	0.08	—	—	—	—	—	—	—	—	—	0.0023			
DDT	0.02	ND	ND	—	—	—	—	—	—	—	—	—	0.001			
Pentachlorophenol	ND	ND	11.5	—	—	—	—	—	—	—	—	—	7.9			
Total PCBs	—	—	—	0.64	ND	ND	ND	ND	ND	ND	ND	ND	0.03			

Note: Concentrations presented in $\mu\text{g/L}$ of total recoverable metal.

ND - not detected

^a Data collected prior to remedial action.

Table 2-7. Summary of Hazardous Substances Detected in Commencement Bay Sediments at Concentrations Exceeding the SQS

SURVEY	YEAR	STATION LOCATIONS	SUBSTANCES EXCEEDING SQS	
			METALS/ METALLOIDS	ORGANIC COMPOUNDS
National Oceanic and Atmospheric Administration OMPA Survey of Puget Sound	1979–1980	Commencement Bay and Waterways	arsenic copper mercury	hexachlorobutadiene PCBs
Commencement Bay Deep Water Survey ^a	1982	Central Commencement Bay	none	bis(2-ethylhexyl)phthalate hexachlorobutadiene
Commencement Bay Nearshore/Tideflats RI/FS	1984–1986	Thea Foss/Wheeler-Osgood Waterways	cadmium mercury lead zinc	LPAHs HPAHs phthalate esters phenols VOCs PCBs
Commencement Bay Nearshore/Tideflats RI/FS	1984–1986	Middle Waterway	arsenic copper mercury silver	LPAH HPAH phthalate esters phenols PCBs
Commencement Bay Nearshore/Tideflats RI/FS	1984–1986	St. Paul Waterway	none	phenols
Commencement Bay Nearshore/Tideflats RI/FS	1984–1986	Milwaukee Waterway	arsenic cadmium copper lead mercury silver zinc	LPAH HPAH phthalate esters phenols PCBs
Sitcum Waterway Pre-Remedial Design Data Report	1991			
Commencement Bay Nearshore/Tideflats RI/FS	1984–1986	Sitcum Waterway	arsenic cadmium copper lead mercury silver zinc	LPAHs HPAHs dibenzofuran PCBs
Sitcum Waterway Pre-Remedial Design Data Report	1991			
Commencement Bay Nearshore/Tideflats RI/FS	1984–1986	Blair Waterway	arsenic cadmium copper lead mercury silver zinc	LPAHs HPAHs phthalate esters phenols PCBs
Sitcum Waterway Pre-Remedial Design Data Report	1991			
Commencement Bay Nearshore/Tideflats RI/FS	1984–1986	Hylebos Waterway	arsenic mercury	LPAHs HPAHs phthalate esters phenols chlorinated hydrocarbons PCBs

Table 2-7. continued

SURVEY	YEAR	STATION LOCATIONS	SUBSTANCES EXCEEDING SQS	
			METALS/ METALLOIDS	ORGANIC COMPOUNDS
Commencement Bay Nearshore/Tideflats RI/FS	1984-1986	Ruston-Pt. Defiance Shoreline	arsenic cadmium copper mercury lead zinc	LPAHs HPAHs phthalate esters phenols chlorinated hydrocarbons dibenzofuran PCBs
ASARCO RI/FS; Supplemental Surveys	1987-1992	Ruston-Pt. Defiance Shoreline in vicinity of slag pile; Yacht basin	arsenic copper lead mercury zinc	phthalate esters phenols

Note: HPAH - high molecular weight polycyclic aromatic hydrocarbon

LPAH - low molecular weight polycyclic aromatic hydrocarbon

PCB - polychlorinated biphenyl

^a Deep water survey data were compared with Apparent Effects Threshold (AET) values because total organic carbon data were not available.

- **Tissues** — Substances identified by the Tacoma-Pierce County Health Department public health assessment for Commencement Bay. SOCs identified by the Tacoma-Pierce County Health Department were presented earlier in Table 2-5.

Table 2-8 provides a summary of the SOCs in the Commencement Bay environment based on the guidelines outlined above. Note that, while a variety of both low and high molecular weight PAHs (LPAHs and HPAHs, respectively) were found to exceed the screening guidelines, for simplicity in presentation, only the general groups of PAHs, (i.e., LPAHs and HPAHs) were listed. In addition to PAHs, 33 other substances were found to exceed the screening guidelines in one or more media.

2.2 DISTRIBUTION OF SUBSTANCES OF CONCERN

The distribution of SOCs in Commencement Bay was determined using existing surface water and sediment data summarized from the studies identified in Section 2.1. Two methods were used to summarize and display the distribution of SOCs. The first method presents the data as a matrix table showing the presence and concentrations of SOCs for discrete areas of the Commencement Bay environment. This method was used for the surface water data because the data set is relatively limited and the information can be easily presented in a tabular format. The distribution of SOCs in the waters of Commencement Bay was presented in Table 2-6.

The second method presents the distribution of SOCs in sediments on Commencement Bay base maps (provided in Appendix A). The purpose of the maps is to show the spatial distribution of samples with concentrations of SOCs that exceeded the screening guidelines, not to summarize the frequency and magnitude of occurrence. The mapping process required the development of base maps that depict the location of all historical sediment chemistry stations in Commencement Bay. Base maps were developed for the following areas:

- | | |
|---------------------------------------|----------------------|
| • Hylebos Waterway | • Blair Waterway |
| • Sitcum Waterway | • Milwaukee Waterway |
| • St. Paul Waterway (Mitigation Site) | • St. Paul Waterway |

Table 2-8. Substances of Concern that Exceeded Applicable Surface Water, Sediment, and Tissue Guidelines

SUBSTANCE	SURFACE WATER (AWQC) ^a	SEDIMENT (SQS) ^b	TISSUE RESIDUE (TPCHD) ^c	AWQC (µg/L)	SQS (mg/kg)
Antimony			✓ ^d	500 ^e	NA
Arsenic	✓	✓	✓	36	57 ^f
Beryllium			✓	NA	NA
Cadmium		✓	✓	9.3	5.1 ^f
Chromium			✓	50	260 ^f
Copper	✓	✓		2.9 ^g	390 ^f
Lead	✓	✓	✓	8.5	450 ^f
Mercury		✓	✓	0.025	0.41 ^f
Nickel			✓	8.3	NA
Selenium			✓	71	NA
Silver		✓		0.92 ^e	6.1 ^f
Zinc		✓	✓	86	410 ^f
LPAHs		✓	✓	NA	170 ^h
HPAH		✓		NA	960 ^h
PCBs	✓	✓	✓	0.03	12 ^h
4,4'-DDD			✓	3.6 ^{e,g}	NA
4,4'-DDE			✓	14 ^{e,g}	NA
1,3-Dichlorobenzene			✓	1970 ⁱ	NA
1,2-Dichlorobenzene		✓		1970 ⁱ	2.3 ^h
1,4-Dichlorobenzene		✓		1970 ⁱ	3.1 ^h
Hexachlorobenzene		✓	✓	NA	0.38 ^h
Hexachlorobutadiene		✓	✓	32 ^{g,h}	3.9 ^h
Bis(2-ethylhexyl)phthalate		✓	✓	360 ^g	47 ^h
Di-n-butyl phthalate		✓		NA	220 ^h
Butylbenzyl phthalate			✓	NA	4.9 ^h
Di-methylphthalate			✓	NA	53 ^h
Dibenzofuran		✓		NA	15 ^h

Table 2-8. continued

SUBSTANCE	SURFACE WATER (AWQC) ^a	SEDIMENT (SQS) ^b	TISSUE RESIDUE (TPCHD) ^c	AWQC (µg/L)	SQS (mg/kg)
Tetrachloroethane			✓	NA	NA
Phenol		✓		5,800 ^e	0.42 ^f
2,4-Dimethylphenol		✓		NA	0.029 ^f
2-Methylphenol		✓		NA	0.063 ^f
4-Methylphenol		✓		NA	0.67 ^f
Pentachlorophenol		✓	✓	7.9	0.36 ^f
Benzyl alcohol		✓		NA	0.057 ^f
Benzoic acid		✓		NA	0.65 ^f

Note: NA - not available

^a Identified as a substance of concern based on U.S. EPA chronic ambient water quality criteria for marine organisms, except copper; for which the acute AWQC was used.

^b Identified as a substance of concern based on Ecology's Sediment Quality Standards (SQS).

^c Identified as a substance of concern based on Tacoma-Pierce County Health Department data.

^d ✓ = substances that exceeded guidelines.

^e Based on U.S. EPA lowest observed effects level (LOEL).

^f SQS based on mg/kg dry weight.

^g Acute criteria; chronic criteria not available.

^h SQS based on mg/kg organic carbon.

ⁱ LOEL for total dichlorobenzenes.

- Middle Waterway
- Commencement Bay open-water
- Thea Foss and Wheeler-Osgood Waterways
- Ruston-Pt. Defiance Shoreline (including the ASARCO study area)

Base maps for the waterways were drawn to include the area from the head of the waterway to the mouth of the waterway. The areas bayward of the mouth of the waterways are included on the Commencement Bay open-water base map. The only exception is the St. Paul Waterway mitigation site, which is outside the St. Paul Waterway, but is presented as a separate base map.

Because of the relatively large number of SOCs associated with sediment in Commencement Bay (see Section 2.1), the distribution of only a subset of the substances was mapped for this report. In all, eight SOCs were selected for mapping, including: arsenic, copper, mercury, LPAH, HPAH, hexachlorobenzene, hexachloro-butadiene, and PCBs.

These eight contaminants were selected based on the following factors:

- The selected SOCs were generally detected in sediments from many areas of Commencement Bay
- The selected SOCs co-occurred with a number of the other SOCs that have been identified in Commencement Bay sediments and hence are reasonably representative of the distribution of the other SOCs
- LPAHs and HPAHs represent groups of compounds that are widely distributed in Commencement Bay sediments, covary, and probably originate from the same types of sources

Separate maps depicting the spatial distributions were produced for each of the eight selected SOCs for each of the areas identified. As with the selection of SOCs, only surficial sediment samples (i.e., 0 to 2 cm) or composites within the first 1.2 m of cores were used in the mapping process. For each map, the distribution of sediment concentrations was presented with symbols that represent discrete ranges in concentrations. The symbols for low, medium, and high ranges of concentrations were the same for each SOC; however, the range of concentrations represented by each symbol changed from one contaminant to another. The range of concentrations represented by each of the three symbols used in mapping

contaminant distribution was based on the guideline concentrations presented in the State of Washington SMS in the following manner:

- Concentrations below the SQS for the SOC were mapped using an open circle
- Concentrations above the SQS guideline but below the MCUL were mapped using a shaded circle
- Concentrations at or above the MCUL were mapped using a solid black circle

Because the purpose of this mapping exercise is to illustrate the distribution of the SOCs in the Injury Study Area and not to determine areas of injury or cleanup, a straight-forward comparison of contaminant concentrations with the SQS was used. The concentration ranges of the SOCs associated with each of the map symbols are presented in Table 2-9.

In some cases, sediment chemistry data for organic compounds could not be compared to the SQS or MCUL because the chemistry data lacked measurements of total organic carbon (TOC) that would allow the calculation of organic carbon-normalized concentrations. For samples without TOC data, the sediment chemistry data were mapped by comparison with AET concentrations, which are calculated based on dry weight concentration. An open square was used when sediment concentrations were below the low AET concentration (1988 AET values). A shaded square was used to represent sediment concentrations that were above the low AET concentrations, but were below the high AET concentrations (1988 AET values).

Table 2-9. Concentration Intervals Used to Map the Distribution of Substances of Concern in Commencement Bay Sediment

SUBSTANCE OF CONCERN	CONCENTRATIONS BELOW SQS	CONCENTRATIONS AT SQS TO BELOW MCUL	CONCENTRATIONS AT OR ABOVE MCUL
			
Arsenic ^{a,b}	<57	57-93	>93
Copper ^a	<390	—	>390
Mercury ^{a,b}	<0.41	0.41-0.59	>0.59
Hexachlorobenzene ^c	<0.38	0.38-2.3	>2.3
Hexachlorobutadiene ^c	<3.9	3.9-6.2	>6.2
LPAH ^c	<370	370-780	>780
HPAH ^c	<960	960-5,300	>5,300
PCBs ^c	<12	12-65	>65

- a Concentration in mg/kg.
- b Total metal (unspeciated).
- c Concentration in mg/kg organic carbon.

2.3 SOURCES OF SUBSTANCES OF CONCERN

This section summarizes the readily available information regarding sources of contamination to the CB/NT Superfund site. The review is based primarily on the CB/NT remedial investigation (Tetra Tech, 1985) and feasibility study (Tetra Tech, 1987), and the Source Control Milestone Reports prepared by Ecology. The investigation of sources of contaminants, contaminated media, and transport mode (i.e., groundwater discharge, spill, or outfall) is being conducted by Ecology and is subject to review by U.S. EPA. At the time this report was prepared, information was only available for six areas of Commencement Bay.

2.3.1 Source Identification and Source Control

Source identification and source control programs, which have been ongoing for several years, are being conducted primarily by Ecology in cooperation with U.S. EPA.

of Tacoma and the Tacoma-Pierce County Health Department. Sources have been investigated primarily for substances identified as a result of sampling conducted during RI/FS studies of contamination in the waterways (Smith, personal communication 1993b; Keeley et al., 1992), but the effort was expanded to consider all possible contamination in the bay.

The source investigations are summarized in Source Control Milestone Reports prepared by Ecology. Milestone reports have been released for problem areas located at the St. Paul, Sitcum, Head of Hylebos, Mouth of Hylebos, Thea Foss, and Wheeler-Osgood Waterways. Because of the low concentrations of substances measured in sediments and funding constraints, source investigations are not being conducted by Ecology for the Blair or Milwaukee Waterways (Smith, personal communication 1993b). The Source Control Milestone Reports are not considered by U.S. EPA to be inclusive of all information known about hazardous substances in the areas. The only investigation of sources along the Ruston-Pt. Defiance Shoreline is the ASARCO Tacoma Smelter Remedial Investigation Report (Parametrix, 1989a).

Additional information about the sources of SOCs may be available for individual sites, but it was beyond the scope of this preliminary effort to review such investigations. A list of sites currently under investigation by Ecology is provided in Table 2-10 (Smith, personal communication 1993b). In addition to those sites, U.S. EPA recently completed the cleanup of six Puyallup Tribe Land Settlement properties located in Commencement Bay (Keeley, personal communication 1993b).

2.3.2 Summary of Identified Contaminant Sources

Tables 2-11, 2-12, and 2-13 summarize the sources of SOCs, organized by location in Commencement Bay. Additional information regarding sources of SOCs not included in the table is provided below.

2.3.2.1 Head of Hylebos Waterway

Recently released Source Control Milestone Reports (Ecology, 1993; Smith personal communication, 1993c) are the main source of information contained in Table 2-11 for the